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Dale Ohnmeiss
ADEQ
3033 N. Central Ave.
Phoenix, AZ 85012-2809

RE: Results from an Independent Study Student Project at ASU on Perchlorate

Dear Mr. Ohnmeiss,

One of our graduate students (Shan Miller) has completed a two-tiered independent study project recently on perchlorate in Arizona. Select results from Shan's work are attached and briefly described below. This information will also be sent to other interested parties. Although I will be out of town for the upcoming perchlorate issues forum later this month, I hope this data provides you with some initial assessment of the impact of perchlorate on drinking water sources in Arizona.

The first tier of the project was to assess perchlorate levels in several surface water supplies and after potable water treatment. Perchlorate occurrence data from our sampling is presented in Table 5-1 (see attached page 15). In brief, perchlorate was found at levels ranging from 5 to 7 ppb in CAP water from Lake Havasu to the Mesa water treatment plant. Perchlorate was not removed by three different water treatment plants (Pyramid Peak, Scottsdale CAP, and Mesa CAP) treating CAP water. Perchlorate was detected in a monitoring well at the Arva Valley recharge site, and represents a blend of CAP and native ground water. Perchlorate was not found in SRP water supplies. A search on municipal wells located near five identified sources of perchlorate was performed (see attached), but the wells were not sampled due to difficulties in timing of access and sample collection.

The second tier of the project was to perform lab-scale experiments with powder activated carbon (PAC) to determine if PAC would sorb perchlorate. PAC is widely used in Arizona to control organic taste and odor compounds. PAC has been shown to remove ions similar to perchlorate, such as bromate and chlorate. Samples of PAC were obtained from the City of Tempe (Hydrodarco B) and a Norit D10 PAC. PAC was added (0 to 250 mg/L) to a model solution containing ionic strength and 50 ppb perchlorate. After 24 hours of equilibration,

perchlorate levels were . statistically different that initial conc rations. Therefore, PAC is not effective at removing perchlorate under drinking water conditions.

We do not plan further sample collection for perchlorate, but would be interested in working with any agency or utility. We would be capable of analyzing perchlorate, interpreting results, and/or performing lab-scale experiments. Please contact me directly by phone (965-2885) or by email (p.westerhoff@asu.edu), if there are any specific questions.

Sincerely,

Paul Westerhoff, Ph.D.
Assistant Professor

3.0 Arizona Perchlorate Sources

Previous studies have shown that perchlorate is present in Lake Havasu therefore, this contaminant will make its way into Arizona through the CAP canal. In addition to the CAP canal, the Arizona Department of Environment Quality (ADEQ) has identified five companies that have received shipments of perchlorate salts between 1950 and 1998. The following is a list of the five companies that have received perchlorate salts and their facility locations along with the legal description of each facility (township, range and section): (Source: Dennis Clayton, ADEQ)

- Universal Propulsion
  25401 N. Central Ave., Phoenix, Az T4N, R3E, S5
- Unidynamics
  102 S. Litchfield Road, Goodyear, Az T1N, R1W, S9
- Talley Defense Systems, Inc.
  4551 E. McKellips Road, Mesa, Az T1N, R6E, S10
  4111 N. Higley Road, Mesa, Az T2N, R6E, S23
  3520 N. Greenfield Road, Mesa, Az T2N, R6E, S33
  3450 N. Greenfield Road, Mesa, Az T2N, R6E, S33
- Aerodyne – Bought out by Universal Propulsion
  Shipped to two sites in Tempe and Chandler – Sites no longer operational
- TRW
  4051 N. Higley Road, Mesa, Az T2N, R6E, S23
  11202 E. Germann Road, Mesa Az T2S, R5E, S3

As a result, there have been several sites within Arizona that have handled perchlorate however, it is unknown if these sites have released perchlorate into the environment. Using the township, range and section numbers of each site , the Arizona Department of Water Resources (ADWR) performed a well search in which they gathered information on every well registered in each legal description. The information gathered from ADWR is presented in Appendix A. This well search included information such as the owner, well type, water use, capacity, depth and well registration number. Using the Quadrant Codes presented in Appendix A, the closest wells to each perchlorate site can be found. Also note, that many of these companies have wells located on their facilities in which they may be currently monitoring for perchlorate. After reviewing the well

search, it is recommended that samples be collected from the following wells to assess the presence of perchlorate in Arizona groundwater sources:

- Talley (T1N, R6E, S10)
  City of Mesa (Reg No. 55-500589 & 55-516690)
  Roosevelt Water District (Reg. No. 55-620493)

- Talley (T2N, R6E, S33)
  C. Jensen (Reg No. 55-636451 & 55-085271)
  Roosevelt Water District (Reg No. 55-620489)

- Universal Propulsion (T4N, R3E, S5)
  Arizona State Land Dept. (Reg No. 55-614014 & 55-614015)

- Unidynamics (T1N, R1W, S9)
  Arizona Public Service (Reg No. 55-540524 & 55-540523)
  EPA Region 9 (Reg No. 55-518280, 55-518279, & 55-520112)

- TRW (T2S, R5E, S3)
  Russey Investments (Reg No. 55-625148)
  Jay Bernstein (Reg No. 55-522138)
  Arizona Agrochemical Co. (Reg No.55-607645, 55-607644, &55-607643)

Many of the wells listed above are either exploration wells or used to supplement peak water demands. Therefore, it may take many months of coordination to obtain samples from these wells.

4.0 Arizona Sample Plan

4.1 Sample Locations and Procedure

To assess the presence of perchlorate in Arizona, samples were collected from various rivers, lakes, canals and treatment plants in the Phoenix area and throughout the State of Arizona. The samples that were collected were analyzed for perchlorate using an IC. The results of this analysis are presented in Table 5-1. Samples were collected from the following types of water:

- Lake Havasu
- CAP water
- Mesa CAP WTP
- Scottsdale CAP WTP
- Glendale Pyramid Peak WTP (CAP water)
- Val Vista WTP (Salt and Verde River water)
- Verde WTP (Verde River water)
- Salt River (above and below metropolitan area)
- Verde River
- Tucson tap water
- Arva Valley Well Water (mixture of groundwater and CAP recharge water)
- Nogalas Wash
- Jose De Sonita River
- 91st Avenue WWTP Effluent
- Mesa WWTP Effluent
- Buckeye Irrigation Water Near Unidynamics facilities

Samples were collected from the WTPs at the sample sink if the water utility had one. If they did not, the samples were collected from a sample tap at the appropriate pipeline (raw water or filter/reservoir effluent). The river and lake samples were taken within 3-inches of the top of the water elevation and always at a location in which the water was free flowing. Therefore, no stagnant water samples were taken.

The water samples were collected in 40 mL glass sample containers. Prior to collecting the samples, the containers were washed and rinsed. This procedure included rinsing the sample containers 3 times with tap water, 3 times with deionized water and 3 times with Super-Q water. A label was placed on each container prior to collecting the sample. The label contained information on the location of the water sample and the date of collection.

5.0 Perchlorate Analysis

5.1 Ion Chromatograph (IC) Procedure

The California Department of Health Services (CADHS) and the Air Force Research Laboratory/Operation Toxicology Branch (AFRL/HEST) have both developed perchlorate detection methods using ion chromatography (IC). These methods enable one to detect perchlorate at a concentration as low as 1 µg/L (1 ppb) (Okamoto, et. al., 1). The water samples that were collected were analyzed using the IC located at the Arizona State University Environmental Lab. The IC within this laboratory is a Dionex Model DX 500 IC.

The IC used includes the following components: a sample loop, injector, guard column, separator column, membrane suppressor, conductivity cell, and computer program recorder. The IC was plumbed to the "auto suppressor in external water mode" (Dionex Operators Manual, 71). This method includes a 1000 µL sample loop, Dionex AS11 suppressor column, and Dionex AG11 guard column. The eluent used for analyzing perchlorate includes 80% 100 mM NaOH and 20% Methanol. The IC used also contained an auto-sampler and Peak Net computer program which records data and allows one to visually observe the peaks and manually set the baselines of each anion.

The water sample is injected into the IC and combined with an eluent that passes through a number of ion exchangers. The anion being analyzed is separated on the basis of its affinity for the anion exchanger (Standard Methods, 4-1). The anion of interest is identified by its retention time and quantified by the peak area. The peak area of the water sample is compared to the standard concentration peak areas to find the water sample concentration.

The following procedure was followed when analyzing the samples for perchlorate using the IC:

1) The IC is plumbed to the "auto suppressor in external water mode". This mode included hooking up an additional deionized water line as well as an additional waste line.

Each sample takes approximately 15 minutes to run. Once the data is received, the results can be analyzed in Peak Net – Optimize. The retention time for perchlorate is between 9 and 10 minutes. Each data file was observed to verify that the baselines were set accurately. Peak Net - Optimize enables one to manually move the baselines of each peak. Once the baseline is set, the peak area and peak height is recorded and compared to the standard equation.

5.2 IC Results

Samples were analyzed on June 13-14, 1998 and July 18-19, 1998. Prior to analyzing the water samples, the standards were analyzed to find the standard linear equation that is used to quantify the perchlorate water sample concentrations. Dr. Westerhoff prepared standard concentrations of 2, 4, 6, 8, 10, and 25 ppb. To find the standard equation, plot the peak area vs. standard concentration and use the linear regression to fit a linear line to the standard concentration data points. The coefficient of determination (r^2) relates the linear fit to the data points. An r^2 value greater than 0.995 is a good fit. Standard equations were calculated for each period the samples were analyzed and resulted in an r^2 value of 0.9989 on June 13, 1998 and an r^2 value of 0.9993 on July 18, 1998. The standard plots, standard equations, and r^2 values can be observed in Appendix B.

To find the perchlorate concentration for each water sample, peaks that occurred between 9 and 10 minutes were analyzed. If a peak with the appropriate retention time was found, the baseline was verified and the peak area was applied to the standard equation to find the perchlorate concentration of the water sample. The data runs obtained for each sample can be seen in Appendix B. Table 5-1 presents the results of the analysis for the water samples taken.

Table 5-1

Water Sample Perchlorate Concentration Results

Sample	Peak Area	Concentration (ppb)
Pyramid Peak CAP WTP Influent	8566	5.8
Pyramid Peak CAP WTP Effluent	8779	5.9
Jose De Sonita River	-	-
Lake Havasu #1 (S. London Bridge)	9760	6.6
Lake Havasu #2 (N. London Bridge)	8278	5.6
Lake Havasu #3 (Mesquite Bay Fish Pt.)	7888	5.3
Lake Havasu #4 (Body Beach Boat Launch)	8411	5.7
Lake Havasu #5 (Cattail Cove)	8805	5.9
Lake Havasu #6 (Havasu Springs)	8428	5.7
Lake Havasu #7 (Buckskin Mtn Park)	8872	6.0
Mesa CAP WTP Effluent	8232	5.5
Mesa CAP WTP Influent	-	-
Nogales Wash	-	-
Salt River (Below Metropolitan Area)	-	-
Salt River #1 (Above Metropolitan Area)	-	-
Salt River #2 (Above Metropolitan Area)	-	-
Scottsdale CAP WTP Influent	8541	5.8
Scottsdale CAP WTP Effluent (Chlorine)	8530	5.7
Scottsdale CAP WTP Effluent (No chlorine)	8670	5.8
Tucson Tap Water	-	-
Verde River	-	-
91st Ave WWTP #1	308	-
91st Ave WWTP #2	-	-
Mesa WWTP #1	-	-
Mesa WWTP #2	-	-
Unidynamics #1 (Farm Canal Bullard St. & Broadway Rd.)	2286	1.4
Unidynamics #2 (Farm Canal - Bullard Curve and Litchfield Rd.)	-	-
Unidynamics #3 (Farm Canal - 115th Ave. and Van Buren)	-	-
Val Vista WTP Influent	115	-
Val Vista WTP Effluent	-	-
Verde WTP Influent	-	-
Verde WTP Effluent	-	-
Arva Valley Well (Groundwater and CAP Recharge Blend)	*3127	3.7

Notes: * This sample was analyzed on July 18-19, 1998 with the PAC experiment.. The other samples were analyzed on June 13-14, 1998. No perchlorate anion peak was found for the samples with a dash (-) under the concentration column.

detection level 1 ug/l

5.3 Analysis Conclusions

The results of this analysis prove that perchlorate is present in Lake Havasu and the CAP canal at concentrations between 5-7 ppb. These results are consistent with the sample program conducted by the Metropolitan Water District of Southern California (MWD) for the Colorado River and Lake Havasu. Furthermore, the results show that the perchlorate concentration is consistent for both the influent and effluent of the CAP WTPs. Perchlorate was also present in the Arva Valley Well sample at a concentration of 3.7 ppb. This sample contains a blend of CAP recharge water and groundwater; therefore, it seems reasonable that perchlorate was found at a lower concentration through the presence of the CAP recharge water. The water blend percentage is not known for the Arva Valley Well. Therefore, it is unknown if any sorption of perchlorate to soil particles is occurring as the CAP recharge water filters down into the groundwater aquifer. Perchlorate was not found in any other location above the detection level.